

Message Text

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SUBJECT: US-USSR ENVIRONMENTAL AGREEMENT PROJECT 02-08-11,
CHANGES IN THE HEAT BALANCE OF THE ATMOSPHERE ON CLIMATE

1. REQUEST EMBASSY PASS FOLLOWING LETTER FROM DR. EDWARD
S. EPSTEIN, US COCHAIRMAN, WORKING GROUP VIII, TO DR. Y.
SEDUNOV, USSR COCHAIRMAN WORKING GROUP VIII, WITH COPY TO
DR. KAZAKOV BOTH OF HYDROMET. REQUEST CONSULATE PASS COPY
TO PROFESSOR BUDYKO AT THE STATE HYDROLOGICAL INSTITUTE.

2. QUOTE JUNE 14, 1977 DEAR DR. SEDUNOV: I AM FORWARD-
ING FOR YOUR INFORMATION THE FOLLOWING ABBREVIATED
ABSTRACTS OF THE PAPERS TO BE PRESENTED BY THE US DELEGA-
TION AT THE LENINGRAD SYMPOSIUM.

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3. THE CLIMATE PROBLEM BY DR. H.E. LANDSBERG.

CLIMATE OFFERS PUZZLES ON ALL SCALES. THESE INCLUDE BOTH
SPACE AND TIME. IN THE LAST INTERVAL OF ONE MILLION YEARS
BEFORE THE PRESENT THERE HAVE BEEN A NUMBER OF PENDULATING
CHANGES BETWEEN GLACIAL AND INTERGLACIAL PERIODS. THESE
HAVE BEEN EXPLAINED BY THE MILANKOVICH HYPOTHESIS IN
TERMS OF CELESTIAL MECHANICS GOVERNING THE RELATIVE
POSITION OF SUN AND EARTH. THIS APPEARS TO BE A PLAUSIBLE
CAUSE BUT THE LEGITIMATE QUESTION REMAINS: WHY WERE

THESE ELEMENTS OF THE EARTH'S PATH AND AXIAL INCLINATION
'HESE ELEMENTS OF THE EARTH'S PATH AND AXIAL INCLINATION
APPARENTLY INOPERATIVE PRIOR TO THE PLEISTOCENE?

THERE IS CONSIDERABLE DISCUSSION ON OTHER SOLAR INFLUENCES
ON THE TERRESTRIAL CLIMATE. THE MODELS OF BUDYKO (1974)
AND SELLERS (1969), INCOMPLETE THOUGH THEY MAY BE, COME
TO THE COMMONSENSE CONCLUSION THAT INCREASES OR DECREASES
OF THE ORDER OF PLUS OR MINUS ONE PERCENT IN SOLAR ENERGY
EMISSION MUST HAVE SERIOUS CLIMATIC REPERCUSSIONS ON
EARTH. THERE STILL ARE CONSIDERABLE UNCERTAINTIES ABOUT
THE EFFECT OF ALBEDO AND CLOUD FEEDBACK MECHANISMS. BUT
THE REAL QUESTION REMAINS: IS THE SUN A VARIABLE STAR AND
HOW MUCH ARE ITS VARIATIONS?

EVERY CLIMATIC RECORD EXHIBITS RELATIVELY HIGH FREQUENCY
OSCILLATIONS. THESE LIE BETWEEN TWO AND THREE YEARS. IN
SOME ELEMENTS THEY SEEM TO BE SUFFICIENTLY REGULAR TO
BE DESIGNATED AS A QUASI-BIENNIAL CYCLE (LANDSBERG, 1963).
THERE IS AN AS YET POORLY SUBSTANTIATED SUSPICION OF
SOLAR INFLUENCES (SUGIURA, 1976; SUGIURA AND POROS, 1977).
THERE ARE ALSO SOME MODELS FOR THE CORRESPONDING EQUA-
TORIAL WIND FLUCTUATIONS. THEY DO NOT SEEM TO BE ABLE TO
ACCOUNT FOR ALL THE OBSERVED PHENOMENA. BUT THESE
BIENNIAL OSCILLATIONS ARE APPARENTLY A VERY PERSISTENT
FEATURE OF THE GENERAL CIRCULATION AND CLARIFICATION OF
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THE WHOLE MECHANISM IS AN URGENT CHALLENGE. IT CANNOT BE
EXCLUDED THAT SUCH TWO TO THREE YEAR FLUCTUATIONS ARE OF
TERRESTRIAL ORIGIN. THEY ARE UNTHINKABLE WITHOUT ASSIGN-
ING A SUBSTANTIAL ROLE TO THE OCEANS. AND JUST WHAT IS
THIS ROLE?

EVEN AFTER SOME OF THE ELEMENTS OF CLIMATOGENESIS HAVE
BEEN TRACED TO PERIODIC SOLAR AND TERRESTRIAL CAUSES;
AFTER NATURAL AND MANMADE INTERFERENCE WITH THE HEAT
BUDGET HAS BEEN CLARIFIED; AFTER PHYSICAL MODELS CAN
REPRODUCE THE VARIOUS EFFECTS, THERE SEEMS TO REMAIN A
RANDOM OR QUASI-RANDOM COMPONENT IN CLIMATE. IF THE
DETERMINISTIC APPROACH CANNOT NARROW THIS DOWN TO A SMALL
PORTION OF THE VARIANCE WE SHALL HAVE TO COUPLE THE MODELS
WITH EXPERIENCED BASED STOCHASTIC MODELS TO SATISFY THE
DEMANDS POSED BY THE PRACTICAL WORLD.

INTERANNUAL VARIABILITY OF THE NORTHERN HEMISPHERE WINTER-
TIME CLIMATE BY JOHN M. WALLACE

LEITH (1973) PROPOSED THAT YEAR TO YEAR CLIMATIC VARIA-
BILITY OVER MIDDLE AND HIGH LATITUDES MAY BE LARGELY A
REFLECTION OF THE FACT THAT NOT ENOUGH WEATHER PATTERNS
ARE SAMPLED DURING A SINGLE SEASON TO OBTAIN TRULY

REPRESENTATIVE STATISTICS. RECENT OBSERVATIONAL RESULTS BY MADDEN (1976) AND BLACKMON AND WALLACE ARE IN AGREEMENT WITH LEITH'S INTERPRETATION. IF THESE RESULTS ARE CORRECT, ONE MUST CONCLUDE THAT THE PROSPECTS OF BEING ABLE TO FORECAST CLIMATE ANOMALIES A SEASON OR MORE IN ADVANCE ARE NOT VERY GOOD, AT LEAST IN MIDDLE AND HIGH LATITUDES.

THE VERTICAL STRUCTURE OF MONTHLY AND SEASONAL CLIMATE ANOMALIES HAS BEEN EXAMINED IN SOME DETAIL. THERE ARE SOME INTERESTING DIFFERENCES IN THE STRUCTURE OVER LAND
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AND SEA. OVER THE OCEANS, AND PARTICULARLY THE EASTERN OCEANS, THE ANOMALIES APPEAR TO BE HIGHLY BAROTROPIC, WITH VERY SMALL THERMAL VARIABILITY. IN CONTRAST, OVER LAND THE VARIABILITY IN THE THERMAL FIELD APPEARS TO PLAY A MUCH MORE IMPORTANT ROLE. THE REASONS FOR THESE DIFFERENCES ARE NOT WELL UNDERSTOOD AT THIS TIME.

THE STRUCTURE OF OCEANIC VARIABILITY BY KLAUS WYRTKI

THE STRUCTURE OF OCEANIC VARIABILITY WILL BE DISCUSSED IN RELATION TO THE TIME AND SPACE SCALES APPLICABLE TO CLIMATIC VARIABILITY WITH TIME SCALES FROM WEEKS TO DECADES. VARIATION ON THESE TIME SCALES ARE ESSENTIALLY GLOBAL IN THE ATMOSPHERE AND BASIN-WIDE IN THE OCEAN. CONSEQUENTLY, IT WILL BE NECESSARY TO CONSIDER LARGE PARTS OF THE OCEAN, ENTIRE CURRENT SYSTEMS, WATER MASSES AND GYRES. THE BASIC MEASURED VARIABLES IN THE OCEAN, WHICH APPEAR ALSO IN THE HYDRODYNAMIC EQUATIONS ARE TEMPERATURE, VELOCITY AND PRESSURE, BUT IN A MODEL OR SYSTEM ATTEMPTING CLIMATIC SIMULATION OR PREDICTION OTHER QUANTITIES MIGHT BE PREFERABLE; HEAT CONTENT, HEAT EXCHANGES, WATER TRANSPORTS, FLOW PATTERNS AND SEA SURFACE TOPOGRAPHY.

IN ORDER TO OBSERVE THE FLUCTUATIONS OF OCEAN STRUCTURE AND CIRCULATION ON TIME SCALES FROM WEEKS TO DECADES, TO DEFINE MAJOR CLIMATIC EVENTS, AND TO DELIVER THE NECESSARY INPUT FOR THE DEVELOPMENT AND TESTING OF THEORIES AND MODELS, IT WILL BE NECESSARY TO DEVELOP A MONITORING SYSTEM. THE VALUE OF USING INTEGRATED QUANTITIES AND INDICES OF CERTAIN LARGE SCALE FEATURES IN CLIMATIC STUDIES WILL BE EMPHASIZED. THE DESIGN OF SUCH A MONITORING SYSTEM WILL BE ILLUSTRATED ON THE EXAMPLE OF THE EL NINO EVENTS IN THE PACIFIC OCEAN.

STRUCTURE OF ATMOSPHERIC VARIABILITY ON A GLOBAL SCALE BY ABRAHAM H. OORT.
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THE FOLLOWING ASPECTS OF THE CLIMATE PROBLEM WILL BE DISCUSSED: (1) AN APPROACH TO THE CLIMATE ISSUES BASED ON CERTAIN PHYSICAL BALANCE REQUIREMENTS, (2) THE STRUCTURE OF PRESENTLY AVAILABLE CLIMATIC DATA SETS, (3) THE OBSERVED YEAR-TO-YEAR VARIABILITY IN THE ATMOSPHERE.

BALANCE EQUATIONS CAN BE APPLIED TO A VARIETY OF SITUATIONS, FOR EXAMPLE, TO STUDY THE CLIMATE SYSTEM AS A WHOLE, AN ATMOSPHERIC OR OCEANIC POLAR CAP, OR ANY OTHER SUBDIVISION IN SPACE AND TIME. THE CAREFUL MEASUREMENT AND INTERPRETATION OF EACH TERM IN THE EQUATIONS WILL LEAD TO A DEEPER INSIGHT IN AN UNDERSTANDING OF THE OPERATIONS OF THE CLIMATE ENGINE.

NEXT THE DATA SETS PRESENTLY AVAILABLE FOR THE VARIOUS ELEMENTS OF THE CLIMATE WILL BE DISCUSSED BRIEFLY WITH THE AID OF FIGURES OF THE GLOBAL DATA DISTRIBUTIONS. AS AN EXAMPLE OF THE TYPE OF RESULTS, PRELIMINARY MEASUREMENTS OF CERTAIN RADIATION FLUX, ENERGY STORAGE AND ENERGY TRANSPORT TERMS WILL BE SHOWN AS A FUNCTION OF LATITUDE AND CALENDAR MONTH. THESE RESULTS SUGGEST THE CRUCIAL IMPORTANCE OF THE OCEANS NOT ONLY AS STORAGE RESERVOIRS OF HEAT, BUT ALSO AS TRANSPORTERS OF ENERGY POLEWARD.

THE AMPLITUDE OF INTERANNUAL VARIATIONS IN THE NORTHERN HEMISPHERE MEAN ATMOSPHERIC TEMPERATURE IS MORE THAN AN ORDER OF MAGNITUDE SMALLER THAN THE SEASONAL AMPLITUDE, THAT IS, ABOUT 0.3 DEGREES CENTIGRADE VERSUS 4 DEGREES CENTIGRADE. MOST OF THIS VARIABILITY IN THE MEAN TEMPERATURE RECORDS APPEARS RANDOM IN NATURE, AT LEAST UP TO THE DECADAL TIME-SCALE. FURTHER, THE MUCH GREATER YEAR-TO-YEAR VARIABILITY OF TEMPERATURE RECORDS AT DIFFERENT LONGITUDES WILL BE DISCUSSED.

PHYSICS OF CLIMATE VARIATIONS VIA PREDICTION OF OCEAN/
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ATMOSPHERE FIELDS BY T. P. BARNETT

SEVERAL DIFFERENT METHODS OF PREDICTING VARIATIONS IN THE OCEAN/ATMOSPHERE SYSTEM ARE BEING EXPLORED. THE PRINCIPAL RESEARCH OBJECTIVES ARE TO DETERMINE (1) IF THERE IS PREDICTABILITY IN THE CLIMATE SYSTEM AND (2) THE PHYSICAL MECHANISMS RESPONSIBLE FOR THE OBSERVED PREDICTIVE SKILL.

THE FIRST APPROACH TO PREDICTION INVOLVES AN EXTENSION OF MULTIVARIATE ANALYSIS TO TEST A PRIORI PHYSICAL HYPOTHESES OF CLIMATE CHANGE. LINEAR PREDICTION THEORY IS EXTENDED IN THE FOLLOWING WAY. POTENTIAL PREDICTORS IN THE SPACE/TIME CONTINUUM ARE COMPRESSED INTO A SINGLE PREDICTOR

MATRIX WHICH IS THEN TRANSFORMED TO A COORDINATE SYSTEM IN WHICH ALL POTENTIAL PREDICTORS ARE ORTHOGONAL. WITH A SUITABLE SCALING TRANSFORMATION A SET OF PREDICTION COEFFICIENTS ARE DEVELOPED FOR INDIVIDUAL STATIONS OR FIELDS. THE MAIN EFFORT OF THE WORK IS TO DETERMINE QUANTITATIVELY THE STATISTICAL UNCERTAINTY ASSOCIATED WITH THE PREDICTION COEFFICIENTS, I.E., THE ARTIFICIAL PREDICTABILITY.

ANOTHER APPROACH TO STUDYING LARGE-SCALE AIR/SEA INTER-ACTIONS VIA PREDICTABILITY STUDIES USES THE CONCEPT OF CLIMATIC ANALOGS. WHILE THE ANALOG PREDICTION METHOD HAS A LONG HISTORY, PRINCIPALLY IN SHORT TIME SCALE WEATHER FORECASTING, IT HAS GENERALLY BEEN DONE IN A RATHER CLASSICAL WAY IN THAT MOST SCHEMES RELY ON FINDING ANALOGS FROM A SINGLE FIELD. THE PRESENT APPROACH DEFINES A SERIES OF VARIABLES RELATED TO ENERGETICS OF THE ENTIRE CLIMATE SYSTEM. THUS THE VARIABLES INCLUDE BOTH OCEAN AND ATMOSPHERE PROPERTIES. THE VARIOUS ENERGETIC INDICES ARE REPRESENTED AS AN ORTHOGONAL SET OF COMPONENTS SUCH THAT THE CLIMATE IS DESCRIBED AT ANY INSTANT BY A SINGLE "STATE VECTOR." THE STATE VECTOR DEFINES THE POSITION OF A "CLIMATE PARTICLE" IN MULTIDIMENSIONAL HYPERSPACE.

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THE ANALOG PROBLEM THEN BECOMES EXAMINATION OF THE PROBABILITY OF OCCURRENCE OF THE CLIMATE PARTICLE IN ANY REGION OF THE HYPERSPACE AS A FUNCTION OF THE RECENT HISTORY OF THE PARTICLE'S TRAJECTORY AND POSITION.

MEASUREMENTS OF THE EARTH'S RADIATION BUDGET AND OTHER CLIMATE PARAMETERS FROM SATELLITES BY THOMAS H. VONDER HAAR

RECENT MEASUREMENTS OF THE EARTH'S RADIATION BUDGET, INCLUDING THE "SOLAR CONSTANT" ARE AVAILABLE FROM U.S. SATELLITES. THESE DATA ARE CONTRASTED WITH EARLIER MEASUREMENTS. THE ENTIRE DATA SET IS DISCUSSED IN TERMS OF VARIABLE EXTERNAL RESPONSE OF THE CLIMATE OF THE ATMOSPHERE-OCEAN SYSTEM. THE PRIMARY ROLE OF CLOUDS IN MODULATING ENERGY EXCHANGE BETWEEN EARTH AND SPACE IS QUANTIFIED USING THE SATELLITE DATA.

CURRENT STATUS AND FUTURE POSSIBILITIES FOR MONITORING CLIMATE PARAMETERS FROM SATELLITES ARE TOPICS COMPRISING THE SECOND PORTION OF THE PRESENTATION.

ASPECTS OF LARGE-SCALE CIRCULATION BY JOHN E. KUTZBACH

THE PAPER WILL REVIEW CERTAIN OBSERVED FEATURES OF LARGE-SCALE MIDLATITUDE CIRCULATION VARIABILITY BASED UPON EIGENVECTOR ANALYSIS (KUTZBACH, 1970) AND MORE RECENT

WORK BY VAN LOON AND OTHERS (1976, 1977). SIMILAR PATTERNS OF LARGE-SCALE CIRCULATION CHANGE HAVE BEEN SIMULATED IN GENERAL CIRCULATION MODELS THROUGH SENSITIVITY STUDIES INVOLVING CHANGES IN OCEAN SURFACE TEMPERATURE (ROWNTREE, KUTZBACH, ET AL., 1977). SOME DEFICIENCIES OF BOTH OBSERVATIONS AND MODELS WILL BE IDENTIFIED AND SUGGESTED IMPROVEMENTS WILL BE NOTED.

A PARTICULAR LARGE GAP IN OUR KNOWLEDGE OF THE OBSERVED
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CIRCULATION CONCERNS THE CONTRIBUTION OF LATENT HEAT RELEASE OVER TROPICAL CONTINENTS TO THE GLOBAL HADLEY CIRCULATION. SOME FIRST ATTEMPTS TO DEFINE THE UPPER TROPOSPHERE WIND FIELD OVER TROPICAL AND SUBTROPICAL SOUTH AMERICA FROM CLOUD MOTIONS OBTAINED VIA GEOSTATIONARY SATELLITE PICTURES (VIDEO LOOPS) WILL BE DESCRIBED. THE PRELIMINARY RESULTS INDICATE CERTAIN MONSOON-LIKE CHARACTERISTICS OF THE CIRCULATION IN THIS REGION DURING SOUTHERN HEMISPHERE SUMMER. THE INTERACTION BETWEEN THESE TROPICAL CIRCULATIONS AND THE MIDLATITUDE CIRCULATION HAS BEEN DIFFICULT TO STUDY AND THE FIRST GARP GLOBAL EXPERIMENT SHOULD OFFER OPPORTUNITIES.

SELECTED TOPICS OF CLIMATE RESEARCH BY EUGENE BIERLY

THE NATIONAL ACADEMY OF SCIENCES HAS COMPLETED A STUDY ON ENERGY AND CLIMATE THAT HIGHLIGHTS THE PROBLEM OF INCREASING CARBON DIOXIDE IN THE ATMOSPHERE AND ITS POSSIBLE CONSEQUENCES. TO COMPARE OBSERVATIONS WITH THEORY, THE LATEST DATA ON GLOBAL TEMPERATURE AND OTHER CLIMATE INDICES ARE DISCUSSED INDICATING A CONTINUATION OF THE GLOBAL OSCILLATORY COOLING OF THE LAST THREE DECADES.

SEVERAL GROUPS HAVE BEEN USING SOPHISTICATED STATISTICAL TECHNIQUES TO ANALYZE TIME SERIES OF TEMPERATURE AND RAINFALL. ONE OF THESE INVESTIGATIONS DEALS WITH THE QUASI-BIENNIAL OSCILLATION AND FEEDBACK PROCESS IN THE ATMOSPHERE-OCEAN EARTH SYSTEMS. THE OTHER DEALS WITH THE USE OF A NONINTEGER TECHNIQUE FOR COMPUTING POWER SPECTRA AND APPLYING THE RESULTS TO RAINFALL DATA. BOTH OF THESE STUDIES WILL BE DISCUSSED IN DETAIL AS EXAMPLES OF SOME OF THE CLIMATE RESEARCH PRESENTLY BEING UNDERTAKEN IN THE UNITED STATES.

CLIMATE DATA NEEDS FOR MODELING BY M. E. SCHLESINGER
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ONE OF THE MAJOR COMPONENTS OF CLIMATE RESEARCH PROGRAMS

WHICH IS ESSENTIAL TO THE UNDERSTANDING OF THE PHYSICAL BASIS OF CLIMATE AND CLIMATIC CHANGE IS THE MATHEMATICAL MODELING OF THE CLIMATIC SYSTEM. THE NEED FOR SUCH MATHEMATICAL MODELING ARISES FROM THE FACTS THAT IT IS IMPOSSIBLE TO CONSTRUCT COMPLETE PHYSICAL MODELS OF THE CLIMATIC SYSTEM IN THE LABORATORY, AND BECAUSE IT IS UNTHINKABLE TO PERFORM ADVERTENT EXPERIMENTS IN SITU ON THE ACTUAL CLIMATIC SYSTEM BECAUSE OF THE POTENTIALLY DELETERIOUS AND IRREVERSIBLE CONSEQUENCES. FOR THESE SAME REASONS THERE IS ALSO A NEED FOR MATHEMATICAL MODELING TO ASSESS THE CONSEQUENCES OF "INADVERTENT" IN SITU CLIMATIC EXPERIMENTS, SUCH AS THE ONGOING INCREASE OF THE CARBON DIOXIDE CONCENTRATION IN THE ATMOSPHERE AND OCEANS.

MATHEMATICAL MODELING OF CLIMATE AND CLIMATIC CHANGE MAY CONVENIENTLY BE DIVIDED INTO THREE INTERDEPENDENT COMPONENTS. THE OBJECTIVES OF THE FIRST COMPONENT, MODEL DESIGN AND DEVELOPMENT, ARE TO DEFINE WHICH PHYSICAL PROCESSES MUST BE INCLUDED IN THE MODEL AND HOW SOPHISTICATED (COMPLEX) MUST THE MODELING OF THESE PROCESSES BE. THE OBJECTIVES OF THE SECOND COMPONENT, MODEL VERIFICATION, ARE TO ASSESS THE FIDELITY OF THE MODEL IN REPRODUCING OBSERVED CLIMATIC STATES AND THEIR VARIATIONS, AND TO DETERMINE WHETHER THE MODEL'S FIDELITY IS SUFFICIENT TO WARRANT THE THIRD COMPONENT, EXPERIMENTATION. OBSERVATIONAL DATA PLAY A CENTRAL ROLE IN THE MATHEMATICAL MODELING OF CLIMATE. EXAMPLES OF THE USE OF DATA IN MODEL DESIGN, VERIFICATION, AND EXPERIMENTATION WILL BE GIVEN.

THE CRYOSPHERE AND CLIMATE VARIABILITY BY H. UNTERSTEINER

ACCORDING TO ESTABLISHED USAGE, THE CRYOSPHERE CONSISTS UNCLASSIFIED

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OF FIVE ELEMENTS: PERMAFROST, ICE SHEETS, MOUNTAIN GLACIERS, SEA ICE, AND SEASONAL SNOW. ON A TIME SCALE OF DECADES, THE CHANGES OBSERVED IN PERMAFROST EXTENT AND DEPTH ARE INSIGNIFICANT. THE OUTER MARGINS OF THE ICE SHEETS OF ANTARCTICA AND GREENLAND HAVE REMAINED STATIONARY FOR MANY CENTURIES. GIVEN THE RECORD OF SEA LEVEL CHANGES OF PRECIPITATION (CONTAINED IN ICE CORES) IT IS UNLIKELY THAT THESE ICE SHEETS ARE IN A CONDITION OF ZERO MASS BALANCE TODAY. THERE IS NO EVIDENCE THAT THE DEGREE OF IMBALANCE IS LARGE ENOUGH TO AFFECT THE EARTH'S WATER BALANCE ON TIME SCALES OF A FEW DECADES.

THE IMPORTANCE OF SNOW AND SEA ICE AS HIGHLY VARIABLE CONSTITUENTS OF THE EARTH'S SURFACE (ALBEDO) HAS BEEN RECOGNIZED. IT STANDS TO REASON THAT SNOW AND ICE MAY BE CAPABLE TO INTERACT WITH ATMOSPHERE AND OCEAN IN A

POSITIVE FEEDBACK MODE. IF SO, THE AMPLITUDE TO WHICH AN INITIAL PERTURBATION CAN GROW MUST BE LIMITED, SINCE DURING THE LAST TEN MILLION YEARS (AND PERHAPS MUCH LONGER) THE EARTH WAS NEVER ENTIRELY FREE OF ICE OR ENTIRELY ICE-COVERED.

BOTH SEA ICE, AND ESPECIALLY, SEASONAL SNOW HAVE A LARGE ANNUAL AMPLITUDE. IT APPEARS THAT, IN ORDER TO ASSESS THE ROLE OF THESE ELEMENTS OF THE CRYOSPHERE IN CLIMATIC VARIATIONS, THE PRIMARY TASK SHOULD BE TO TEST GLOBAL ATMOSPHERE-OCEAN MODELS FOR THEIR ABILITY TO REPRODUCE THE MEAN ANNUAL CYCLE OF SNOW AND ICE. FOR THE CASE OF SNOW, THIS OBVIOUSLY REQUIRES THE MODEL'S ABILITY TO REPRODUCE ACCURATELY TEMPERATURE AND PRECIPITATION. IN THE CASE OF SEA ICE, ITS HORIZONTAL MOBILITY ADDS CONSIDERABLE FURTHER COMPLICATIONS WHICH ARE THE SUBJECT OF CURRENT STUDIES OF ICE DYNAMICS. THERE IS SOME TENTATIVE EVIDENCE THAT SURFACE TEMPERATURE AND SEA ICE EXTENT IN THE SOUTHERN OCEAN ARE RELATED IN SUCH A WAY AS TO INDICATE A NEGATIVE (STABLE) FEEDBACK.

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WITH BEST REGARDS, EDWARD S. EPSTEIN UNQUOTE CHRISTOPHER

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